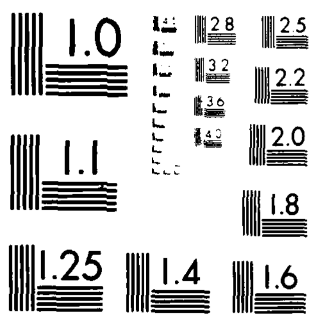
AD-A122 420 PERSONNEL SUBSTITUTION AND NAVY AVIATION READINESS(U) 1/1
CENTER FOR NAVAL ANALYSES ALEXANDRIA VA NAVAL STUDIES
GROUP A J MARCUS OCT 82 CNA-PP-363 N00014-76-C-0001

UNCLASSIFIED F/G 5/9 NL

END
DATE
FILMED
1-83
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD A122420

(2)

PROFESSIONAL PAPER 363 / October 1982

PERSONNEL SUBSTITUTION AND NAVY AVIATION READINESS

A. J. Marcus

CNA
CENTER FOR NAVAL ANALYSES

PROFESSIONAL PAPER 363 / October 1982

PERSONNEL SUBSTITUTION AND NAVY AVIATION READINESS

A. J. Marcus

N00014-76-C-0001

Naval Studies Group

CENTER FOR NAVAL ANALYSES

2000 North Beauregard Street, Alexandria, Virginia 22311

TABLE OF CONTENTS

	Page
Background	1
Model	3
Data	6
Results	8
Paygrade	8
Least Cost Force	11
Experience	15
Education and AFQT	18
Summary	20
Prospects	22
References	24
Appendix A: Empirical Results	A-1

PERSONNEL CHARACTERISTICS AND NAVY AVIATION SQUADRON PERFORMANCE: A PRODUCTION FUNCTION APPROACH

BACKGROUND

The Navy's ability to carry out its peacetime and wartime missions depend heavily on the quality of its enlisted force. Thirty percent of the Navy's annual budget is spent on personnel compensation. Depite the large expenditure on personnel each year it is still an open question whether current personnel requirements provide an efficient allocation of manpower resources. The work reported here is one of a series of analyses underway to determine whether manpower requirements can be developed that will lead to increases in the Navy's level of readiness.

Navy manning documents for classes of ships and aviation squadrons list manpower requirements by rating, NEC and paygrade. These documents are derived from industrial engineering surveys of individual work centers. The required workload is determined for specific tasks, then for each work center as a whole. Minimum manning requirements are calculated based on an approved Navy work week. These requirements are aggregated to create a manning document for the ship or squadron, taking account of time required for training, leave, and other non-productive activity. Shore billets are determined in a similar manner through the SHORSTAMPS System.

This requirements determination process provides detailed descriptions of manning levels and experience mixes by paygrade. In an independent process, the Navy also sets minimum requirements for education and mental ability for incoming recruits. They are based on the probability of successfully completing the first enlistment and on estimates of probable A-school success. Neither process considers directly the possibilities for substitution that exists among personnel with different experience levels and other characteristics or the cost. This paper analyzes the tradeoffs among personnel with different characteristics with respect to their productivity and cost.

The effects of experience, education, mental ability and skill level of enlisted personnel on the performance of aviation squadrons are estimated. The degree of substitutability among various categories of squadron maintenance personnel is analyzed as well. This information can be combined with cost data on different types of personnel to determine a cost-minimizing force mix.

Most research on personnel productivity in the military has relied either on survey information about the relative performance of individuals with different personnel characteristics, or on written tests that attempt to measure an individual's ability to perform his job. Few studies have attempted to relate personnel resources to larger measures of military readiness. Several studies of readiness have been conducted at CNA, but they have not concentrated on manpower requirements or substitution possibilities. (For a review of this research, see [1].)

MODEL

We estimate a production function that relates labor inputs to measures of the output of aviation squadrons. Since we have no strong priors about the shape of this production function or the ability of specific types of labor inputs to substitute for each other, a flexible production function is desired.

We have chosen the generalized Leontief production function suggested by Diewert (2). This function has the form:

$$Q = \sum_{i=1}^{n} a_i X_i + \sum_{i=1}^{n} \sum_{\substack{j=1 \\ j \neq i}}^{n} b^1_{ij} (X_i X_j)^{1/2} \qquad (1)$$

where Q is output and X_i, X_j are input quantities. Equality of b_{ij} and b_{ji} is required for estimation.* If one ignores the cross-product terms, (1) becomes a linear production function.

The marginal product of input X_i is:

$$f_i = \frac{\partial Q}{\partial X_i} = a_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} b_{ij} (X_j / X_i)^{1/2} \qquad (2)$$

* The coefficient estimated by the regression analysis is $b^1_{ij} = b_{ij/2} = b_{ji/2}$.

A well-behaved production function satisfies two conditions.

It should be characterized by monotonic increases in output for increases in any input, i.e., that $f_i > 0$. Clearly, over certain ranges of X the generalized Leontief production functions can possess uneconomic regions where $f_i < 0$. This monotonicity condition can be tested with the parameter values estimated at appropriate input levels.

The second requirement is that the isoquants determined by the production function be convex. Convexity requires that the bordered Hessian matrix of first and second partial derivatives is negative definite. Again, the bordered Hessian must be evaluated for the appropriate parameter and input values.

The own second derivatives and cross-partial derivatives of the generalized Leontief function are respectively:

$$f_{ii} = \frac{\partial^2 Q}{\partial X_i{}^2} = -1/2 \sum_{\substack{j=1 \\ j \neq i}}^{n} b_{ij} (X_j / X_i{}^3)^{1/2} \tag{3}$$

and

$$f_{ij} = \frac{\partial^2 Q}{\partial X_i \partial X_j} = 1/2 \; b_{ij} (X_i X_j)^{-1/2}. \tag{4}$$

These derivatives are calculated and inserted into the Hessian matrix to test the convexity condition.

From estimation of the production function it is possible to derive the appropriate demand requirements. Conditions for the optimal relative demand requirements are that the ratio of marginal product to price are equal for all inputs. Marginal products are derived from (2) and given information on the relative cost of each category of labor inputs one can solve for the optimal mix of labor groups. In practice this procedure is cast as a cost-minimizing problem subject to an output constraint and solved by non-linear methods.

The production function approach generates estimates of substitution elasticities. They provide insight about tradeoffs among inputs. If two types of labor are good substitutes then the Navy can respond to a reduction in one input by increasing the number of the second type. If the inputs are not good substitutes then this type of tradeoff becomes more difficult.* The Allen partial elasticity of substitution is

$$\sigma_{ij} = \left(\sum_{i=1}^{n} f_i X_i / X_i X_j\right)\left(|\bar{F}_{ij}| / |\bar{F}|\right) \quad i\ ,\ j = 1,\ n \tag{5}$$

* For a more developed discussion of these issues see [3].

where $|F|$ is the determinant of the bordered Hessian matrix and $|F_{ij}|$ is the cofactor of f_{ij} in $|F|$. As equations (2) to (4) indicate, the values of the elements of $|\bar{F}|$ and σ_{ij} depend on the levels of X_i.

DATA

Flight Activity of Naval Aircraft, OpNav Notice C3700 (6/77 - 12/80), provided the following quarterly information on deployed squadrons:

- Type and number of aircraft
- Atlantic or Pacific Fleet
- Carrier on which deployed
- Total squadron flying hours in the quarter
- Total squadron flights and landings in the quarter
- Average hours flown per operating aircraft
- Mission capable rates.

Once the squadrons were identified, their Unit Identification Codes (UIC) were matched to the squadron number. Given the UIC, the enlisted personnel attached to the squadron were identified from the Enlisted Master Records for the corresponding dates. To be sure that these personnel were aboard the carrier, we examined their Onboard Accounting Category Codes and transfer dates. The following characteristics of the squadron's enlisted personnel were calculated:

- Number of high school graduates and non-graduates,
- Numbers in each paygrade,
- Number by years of experience,
- Number in each mental group category,
- Number by training completed,
- Number by tenure in the squadron,
- Number by occupational group, and
- Combinations of various categories.

Observations were obtained for 292 quarterly squadron deployments. Squadrons have an average of approximately 230 enlisted personnel. Within squadrons enlisted men are assigned to numerous occupations requiring very different levels of training and ability. To control for occupational differences, enlisted men were assigned to three categories based on the average skill level of their rating.* Rating group 1 includes personnel in highly technical ratings. Group 2 contains technical ratings and group 3, non-technical ratings. Estimation of the squadron production function was conducted for the squadron as a whole and separately within each rating group.

---

* See table A-1 for the assignment algorithm.

RESULTS

Preliminary analysis indicated that relationships between labor inputs and measures of effectiveness were significantly different for the three types of aircraft squadrons, F-4, F-14 and A-7. Analysis was conducted separately for the different aircraft types. Sample sizes were very small for F-4 and F-14 aircraft and results were unreliable. As a result, only analysis of the 180 attack squadron deployments is reported.

PAYGRADE

Most enlisted manpower requirements are defined in terms of experience and paygrade. Estimates of a production function with labor input measured by the number of personnel in specific experience and paygrade levels can confirm whether or not the current mix of junior and senior personnel is appropriate. Analysis of paygrade was conducted first. Personnel were grouped into three paygrade categories, E1-E3, E4-E6, and E7 - E9. The following equation was then estimated in two versions, the first using Number of Flights and the second using the quarterly Mission Capable Rate (MCR) as the measure of output.

$$Q = a_1X_1 + a_2X_2 + a_3X_3 + a_4P + b_{12}(X_1X_2)^{1/2} + b_{13}(X_1X_3)^{1/2} + b_{23}(X_2X_3)^{1/2} + b_{14}(X_1P)^{1/2} + b_{24}(X_2P)^{1/2} + b_{34}(X_3P)^{1/2}. \quad (6)$$

where X_1 = Personnel in grades E1-E3

X_2 = Personnel in grades E4-E6

X_3 = Personnel in grades E7-E9

P = Average number of operating aircraft.

Regression results are shown in table A-2. Results for each of the three rating groups, separately are displayed in table A-3. Estimates of the marginal product of each input are calculated as in (2), using estimated parameter values and mean levels of the independent variables. Table 1 presents the marginal products calculated from these regressions.

These results are highly consistent and display the appropriate pattern of increasing output at higher grade levels. The major exception is row 4, which has a perverse result, along with the value for mid-grade personnel in row 6. The most striking finding is the extremely high marginal productivity of the most senior personnel. This suggests that substantial improvements in readiness can be obtained by increasing the number of top-grade enlisted men.

Table 2 summarizes the substitution elasticities among inputs for each of the three rating groups. Positive (negative) signs indicate that the inputs are substitutes (complements). The actual substitution elasticity estimates are provided in table A-4.

TABLE 1

MARGINAL PRODUCTS OF PAYGRADE GROUPS

		E1-E3	E4-E6	E7-E9	Aircraft
	Mean Level	[82]*	[132]	[14]	[13.2]
(1)	Flights [846]	-1.2 (29.1)	2.9 (1.6)	30.7 (9.4)	13.9
(2)	MCR [59]	.08 (.08)	.15 (.10)	.72 (.40)	1.98
			Rating Group 1		
		[10]	[42]	[5]	
(3)	Flights	7.2	8.0	26.5	25.8
(4)	MCR	1.07	.36	-.07	2.56
			Rating Group 2		
		[25]	[52]	[5]	
(5)	Flights	4.9	11.2	50.5	-7.8
(6)	MCR	.56	.39	1.67	1.38
			Rating Group 3		
		[46]	[39]	[4]	
(7)	Flights	-4.8	11.7	44.8	35.9
(8)	MCR	-.07	.64	.68	2.9

---

* Bracket terms are mean values of variables. MCR is measured on a scale from 0 to 100. Standard errors for marginal products involve tedious calculations. They are presented, in parentheses, for the entire squadron sample as an indication of the relative precision of the estimate.

TABLE 2

SUBSTITUTION ELASTICITIES BY PAYGRADE
FOR RATINGS GROUPS 1, 2, 3
(Flight Equations)

	E1-E3	E4-E6	E7-E9
E4-E6	+++		
E7-E9	++-	-+-	
Aircraft	-++	+++	---

At this point, the value of a flexible functional form for the production function becomes apparent. Although analysis below argues that a more senior force is desireable the increase in senior personnel is somewhat less than might be expected from an examination of table 1. The first reason is that the marginal productivity of senior personnel is high in part because of their very small numbers and this production function allows the marginal product to decline as input levels increase. Thus as the number of senior personnel is increased their marginal product will fall quite quickly. Secondly , as is seen in table 2, this form allows E7-E9 personnel to be complements with more junior personnel which reduces the relative value of substituting senior for junior personnel.

LEAST COST FORCE

In order to test the applicability of results from the estimation conducted, a least-cost force mix by paygrade was constructed. Costs for personnel in each paygrade category were derived from the Enlisted Billet Cost Model [4] and the minimum cost force for a 12-plane squadron was determined subject to the condition that output be at least equal to the current level. This is the constrained-minimization problem presented below:

$$\text{Min}_{X_1, X_2, X_3} \sum_{i=1}^{3} P_i X_i + \lambda(Q_0 - Q(X)) \tag{7}$$

where P_i $\equiv$ Average cost of personnel in category i

X_i $\equiv$ Number of personnel in category i

Q_0 $\equiv$ Current number of flights

$Q(X)$ $\equiv$ Number of flights predicted from equation (1).

The solution of this minimization problem is shown in table 3 using parameter values from the regression of flights on paygrade categories for all personnel (table A-2).

TABLE 3

CURRENT AND LEAST-COST FORCE BY PAYGRADE
FOR 12-PLANE A-7 SQUADRONS

	E1-E3	E4-E6	E7-E9	\$ Cost (10^3)
Current	75	120	12	4,190
Least-cost	57	107	19	3,860
Difference	-18	-13	+7	330

Cost/Man (10^3): E1-E3 (14.4), E4-E6 (22.4), E7-E9 (34.5)

The results imply that a shift in resources from the bottom six paygrades to the top three would result in an eight percent cost savings while maintaining the current effectiveness level. This solution assumes constant marginal costs. The true marginal cost will rise with increased manning in any specific manpower category and therefore the solution overstates the optimal tradeoffs. These results are suggestive of efficient substitution possibilities, however. Although all results point in the same direction, similar analysis within rating groups produced unsatisfactory results.

The categories of paygrades chosen are essentially arbitrary. As a check on the sensitivity of the analysis to the grouping of paygrades, the same analysis was conducted using different paygrade groups. Because many personnel reach the E-4 level within their first term, a second set of estimates was derived that assigned them to the most junior group. Marginal product estimates from this specification are displayed in table 4. This set of results show a higher marginal product for the mid-level group, as expected. As with the first set of estimates, results based on quarterly flights are more consistent than those using MCR as the measure of performance.

The estimates based on different manpower categories produce somewhat different marginal product estimates. In order to test the effect of this on the policy implications of the model, a least-cost

TABLE 4

MARGINAL PRODUCTS OF PAYGRADE GROUPS

	E1-E4	E5-E6	E7-E9	Aircraft
Mean level	[141]	[71]	[13]	[13.1]
(1) Flights	-0.5	6.2	29.1	9.9
(2) MCR	.046	.339	.342	2.114
		Rating Group 1		
	[29]	[23]	[5]	
(3) Flights	19.2	-4.1	19.5	21.8
(4) MCR	.184	.323	.084	3.538
		Rating Group 2		
	[50]	[26]	[5]	
(5) Flights	3.0	18.2	36.7	8.1
(6) MCR	.418	.462	1.341	1.689
		Rating Group 3		
	[63]	[22]	[4]	
(7) Flights	-3.3	20.7	45.8	34.5
(8) MCR	-.017	1.508	.658	2.234

force is shown in table 5. Again the optimal solution implies that a dramatic increase in the number of top-grade personnel and a substantial drop in the number of the most junior personnel would lead to significant savings. A final test, including the E-7s in the mid-grade group, was conducted. In this case the marginal product for the E-8, E-9 group dropped dramatically. An average squadron had only three or four men in this category, however, so confidence in this finding must be limited. On balance then, this analysis finds consistent evidence that a more senior force is an efficient change from current manning.

TABLE 5

CURRENT AND LEAST-COST FORCE BY PAYGRADE
FOR 12-PLANE A-7 SQUADRONS

	E1-E4	E5-E6	E7-E9	\$ Cost (10^3)
Current	129	65	12	4,304
Least-cost	86	60	23	3,796
Difference	-43	-5	+11	508

Cost/Man (10^3) E1-E4 (16.6), E5-E6 (24.5), E8-E9 (34.5)

EXPERIENCE

Promotion to higher ranks is dependent on both time in service and performance. Therefore, it is not surprising that output is related to higher paygrade personnel. Related analysis was conducted based on experience alone, as measured by years in service. Personnel were assigned to three experience categories, 1-4 years, 5-8 years, and 9 or more (corresponding to first term, second term and career personnel). Regression results are displayed in tables A-5 - A-6.

Table 6 presents the calculated marginal products for the experience categories. Again, the estimates are consistent and indicate significant improvement with experience. Anomalous results are limited to low estimates for second term personnel (rows 1, 3, 4) and one wrong sign for aircraft in row 5.

TABLE 6

MARGINAL PRODUCTS OF EXPERIENCE GROUPS

		1-4 Years	5-8 Years	9+ Years	Aircraft
	Mean Level	[146]	[29]	[53]	[13.2]
DV					
(1)	Flights	1.3	-2.8	14.5	.5
(2)	MCR	.01	.12	.44	2.25
		Rating Group 1			
		[32]	[10]	[15]	
(3)	Flights	17.0	-4.4	2.0	24.2
(4)	MCR	.14	.01	.34	3.66
		Rating Group 2			
		[52]	[10]	[20]	
(5)	Flights*	5.8	9.6	3.41	-18.1
(6)	MCR	.30	.59	1.15	.83
		Rating Group 3			
		[62]	[9]	[18]	
(7)	Flights	.3	1.7	37.9	14.8
(8)	MCR	.02	.55	1.53	1.90

* Convexity condition not satisfied.

Estimates of substitution elasticities are more varied for the experience variable than for paygrade. They are, however, generally reasonable. Table 7 presents the elasticity estimates. Cost minimization experiments have not been conducted for experience groups due to difficulties in deriving appropriate prices. A glance at table 6 makes it clear, however, that a more experienced enlisted force is probably desireable.

TABLE 7

SUBSTITUTION ELASTICITIES FOR EXPERIENCE GROUPS,
RATING GROUPS 1, 2, 3
(Flight Equations)

	1-4 Years	5-8 Years	9+ Years
5-8 years	- + +		
9+ years	+ - -	+ - -	
Aircraft	+ + +	+ - +	- - 0

Current manpower requirements are defined basically by experience and paygrade. As such, they were the central variables in this analysis. The Navy does impose minimum educational and ability requirements on incoming recruits, however. It is of interest to know the effects of these characteristics on productivity as an input into the current popular debate on whether or not the military requires higher "quality" personnel.

EDUCATION AND AFQT

In order to estimate the effects of education on productivity, personnel were assigned to three categories. The first includes high school non-graduates and those with General Educational Development Certificates (GED). The second and largest category is made up of high school graduates. The final category contains personnel with education beyond high school. As with the earlier work analysis was conducted for the squadron as a whole and separately within occupational categories. Regression estimates are found in tables A-7 and A-8.

Table 8 presents the estimated marginal products for each educational category evaluated at current mean levels of the inputs. When output is measured by total flights an appropriate pattern is found, personnel with more education are more productive. Only the estimate for non-graduates in row (5) is inconsistent with the expected result. Results with MCR as an alternative measure of output are generally unreasonable.

In addition to educational categories, estimates of the effects of mental ability, as measured by mental group categories, were obtained. Three categories, MG 1 and 2, MG3, and MG 4 and 5, were included in the production function regressions, as presented in tables A-9 and A-10. Table 9 provides the marginal product estimates. These results are disappointing. Previous studies at CNA have found tenuous and conflicting results on the value of mental ability in predicting performance [5, 6]. We hesitate to accept the proposition that intelligence has no relation to performance, but we cannot measure the relationship with any confidence.

TABLE 8

MARGINAL PRODUCTS OF EDUCATIONAL GROUPS

	NHS/GED	HSG	HS+	Aircraft
Mean Level	[53]	[158]	[18]	[13.2]
(1) Flights	-.5	1.9	10.6	26.8
(2) MCR	.30	.06	-.04	2.20
		Rating Group 1		
	[7]	[42]	[7]	
(3) Flights	4.8	9.0	12.9	22.4
(4) MCR	.21	.44	-.64	3.01
		Rating Group 2		
	[21]	[57]	[3]	
(5) Flights	19.1	9.9	17.6	-15.9
(6) MCR	.68	.33	.78	1.67
		Rating Group 3		
	[24]	[58]	[7]	
(7) Flights	-14.6	7.8	8.8	53.1
(8) MCR	-.02	-.01	.37	4.30

TABLE 9

MARGINAL PRODUCTS OF MENTAL GROUPS

		MG1-2	MG3	MG4-5	Aircraft
	Mean Level	[77]	[100]	[50]	[13.2]
(1)	Flights	7.7	.5	2.1	13.7
(2)	MCR	.21	-.03	.39	1.49
			Rating Group 1		
		[37]	[17]	[3]	
(3)	Flights	6.4	7.7	25.1	29.2
(4)	MCR	.06	.52	1.53	3.15
			Rating Group 2		
		[20]	[41]	[21]	
(5)	Flights	18.7	9.6	6.5	-2.7
(6)	MCR	.44	.37	.89	1.18
			Rating Group 3		
		[20]	[43]	[26]	
(7)	Flights	6.1	-2.5	.9	67.2
(8)	MCR	.20	.12	-.02	3.97

SUMMARY

The analysis in this study has examined the relationship between the characteristics of enlisted personnel and unit performance. The results confirm that unit performance is affected by the quality of personnel. The most consistent findings are the effects of more senior personnel on performance. The results for education and mental ability as predictors of performance are generally reasonable although much less consistent.

Personnel in the upper paygrades were found to be substantially more productive than junior personnel. Estimates of substitution elasticities imply that E1-E3 personnel are substitutes for E4-E6 enlisted men but that E7-E9 personnel may be complements for both groups. The results were used to derive a simulated least-cost force. This simulation indicates that a shift in resources to the top three paygrades could result in significant savings in personnel cost while maintaining current effectiveness levels.

Measures of experience based on length of service rather than rank were employed as well. Similar results were obtained to those using paygrade. Productivity was found to increase substantially with additional years of experience. Again, this finding is particularly striking for the most senior personnel. Productivity studies based on individual performance measures have had great difficulty in estimating productivity for this group due to the administrative nature of their jobs. This result lends support to the argument that measures of unit performance provide insights unavailable in research which examine individual performance.

Estimates of the relationship between unit performance and levels of education and mental ability display mixed results. Increases in productivity at higher levels of education are observed when performance is measured by quarterly flights but not when MCR is used. The effects of mental ability on performance cannot be established with any confidence.

PROSPECTS

Current efforts are underway at CNA that will provide estimates of the relative cost of personnel with different levels of education and mental ability. They will allow for estimates of the optimal mix of men with varying personal characteristics. However, regression estimates for these equations do not seem to be very stable, and it may be difficult to place a great deal of confidence in the resulting mix predictions. Nonetheless, these estimates have potential as a first step in attacking these issues.

Data are available on other characteristics of aviation squadrons that could improve the precision of estimates of output. Measures of length and location of deployments, activities conducted, and material readiness, for example, would all be useful as explanatory variables. Unfortunately, none of these data are in condition to be used without extensive effort. For the immediate purpose of determining manpower requirements, it is unlikely that further data development will provide dramatic improvements. For studying readiness issues in general and personnel requirements in particular, however, production function analysis using flexible functional forms, such as the generalized Leontief, offer considerable promise.

This CNA study is one in a series of projects aimed at measuring personnel productivity and analyzing manpower requirements. In addition to this study, and others that have measured unit performance as a function of labor inputs, studies based on surveys, proficiency exam scores, time to promotion and simulation models are being used to measure the performance of personnel in the Navy. (See [7] for a review of current work and future plans.) These measures of performance are being integrated with our continuing supply analyses. As final products, we seek models which parameterize both supply and demand. These models can be used to analyze a wide variety of policy issues such as alternative force structures, contract length and optimal bonus levels.

REFERENCES

[1] Center for Naval Analyses, Memorandum (CNA)81-1675.10, "Review of Literature Relevant to the Personnel Productivity Study," by A.J. Marcus, 23 Aug 1982

[2] Diewert, W.E., "An Application of the Shephard Duality Theorem: A Generalized Leontief Production Function," Journal of Political Economy, Vol. 75, 1971

[3] Center for Naval Analyses, Memorandum (CNA)81-1376, "Squadron Readiness: A Production Function Approach," by M.K. Nakada, K.B. Garvey, and A.J. Marcus, 1 Sep 1981

[4] Naval Personnel Research and Development Center, SR 80-7, "Life Cycle Navy Enlisted Billet Costs - FY 80," January 1980

[5] Center for Naval Analyses, Memorandum (CNA)81-0048, "Relating Enlistment Standards to Job Performance: A Pilot Study for Two Navy Ratings," P.M. Lurie, 15 Jan 1981

[6] Center for Naval Analyses, Memorandum (CNA)81-1311, "Predicting Advancement Exam Scores: A Test Case," J.W. Fletcher, A.J. Marcus, and K.D. Rutledge, 19 Oct 1981

[7] Center for Naval Analyses, CRC 466, "Personnel Characteristics and the Performance of Navy Men," A.J. Marcus, et al., Sep 1982

APPENDIX A

EMPIRICAL RESULTS

TABLE A-1

ASSIGNMENT PROCEDURE FOR RATINGS[a]

Rating Group 1	Rating Group 2	Rating Group 3
Highly Technical	Technical	Semi-Technical
Air Traffic Controller (AC)	Aviation Machinist's Mate (AD)	All Others
Aviation Electricians Mate (AE)	Aviation Structural Mechanic (AM)	
Aviation Fire Control Technician (AQ)	Aviation Ordnanceman (AO)	
Aviation Electronics Technician (AT)	Aviation Support Equipment Technician (AS)	
Aviation Antisubmarine Warfare Technician (AY)	Aircrew Survival Equipmentman (PR)	

[a] Assignments based on skill classification by Op-110C.

TABLE A-2

COEFFICIENT ESTIMATES: PERFORMANCE ON PAYGRADE

Variable	Flights	MCR
(X_1) E1-E3	-59.1 (27.0)[a]	-3.16 (1.26)
(X_2) E4-E6	-49.4 (34.8)	-4.06 (1.62)
(X_3) E7-E9	43.1 (68.8)	-1.91 (3.21)
(P) Aircraft	-513.1 (359.2)	-42.9 (16.7)
$(X_1X_2)^{1/2}$	-24.1 (42.4)	-1.30 (1.98)
$(X_1X_3)^{1/2}$	9.6 (73.0)	4.51 (3.40)
$(X_2X_3)^{1/2}$	158.8 (92.7)	5.91 (4.32)
$(X_1P)^{1/2}$	355.0 (179.7)	15.7 (8.4)
$(X_2P)^{1/2}$	230.2 (174.1)	23.9 (8.1)
$(X_3P)^{1/2}$	-551.8 (338.1)	-24.6 (15.8)

[a] Std. errors in parentheses.

TABLE A-3

COEFFICIENT ESTIMATES: PERFORMANCE ON PAYGRADE BY RATING GROUP

Variable	Rating Group 1 Flights	Rating Group 1 MCR	Rating Group 2 Flights	Rating Group 2 MCR	Rating Group 3 Flights	Rating Group 3 MCR
(X_1) E1-E3	-3.8	2.83	-40.6	-1.11	-48.9	-4.10
	(71.2)	(3.22)	(48.3)	(2.23)	(30.9)	(1.41)
(X_2) E4-E6	-91.2	-8.12	40.1	-4.45	-30.5	-1.02
	(68.1)	(3.08)	(51.4)	(2.38)	(79.7)	(3.63)
(X_3) E7-E9	-175.0	-8.05	-84.6	2.52	31.8	-1.46
	(143.8)	(6.51)	(138.9)	(6.42)	(53.7)	(2.45)
(P) Aircraft	-36.6	-2.93	154.0	-7.96	-171.5	-32.67
	(177.2)	(8.02)	(345.5)	(15.98)	(284.0)	(12.95)
$(X_1X_2)^{1/2}$	8.9	-1.07	-3.9	-0.78	40.1	-3.18
	(114.2)	(5.17)	(68.4)	(3.17)	(70.4)	(3.21)
$(X_1X_3)^{1/2}$	119.9	9.66	1.77	10.26	-97.2	-[illegible].84
	(152.4)	(6.90)	(103.4)	(4.78)	(77.5)	(3.53)
$(X_2X_3)^{1/2}$	236.6	17.94	160.9	4.75	46.9	-5.33
	(208.1)	(9.42)	(144.0)	(6.66)	(127.5)	(5.81)
$(X_1P)^{1/2}$	-69.0	-7.04	132.6	-0.17	147.4	21.00
	(228.7)	(10.36)	(202.3)	(9.36)	(172.5)	(7.86)
$(X_2P)^{1/2}$	200.6	20.15	-208.5	17.27	45.3	14.47
	(193.8)	(8.78)	(236.1)	(10.92)	(251.1)	(11.45)
$(X_3P)^{1/2}$	-281.2	-30.65	-153.5	-24.64	115.4	12.98
	(430.3)	(19.48)	(344.3)	(15.93)	(263.2)	(12.00)

TABLE A-4

SUBSTITUTION ELASTICITIES BY PAYGRADE
FOR RATING GROUPS 1, 2, 3
(Flight Equations)

	E1-E3	E4-E6	E7-E9
Rating Group 1			
E4-E6	.4		
E7-E9	2.3	-.1	
Aircraft	-1.3	.1	-.4
Rating Group 2			
E4-E6	.1		
E7-E9	.3	.4	
Aircraft	.6	.1	-.1
Rating Group 3			
E4-E6	1.5		
E7-E9	-4.7	-1.7	
Aircraft	1.5	1.1	-2.3

TABLE A-5

COEFFICIENT ESTIMATES: PERFORMANCE ON EXPERIENCE

	Flights	MCR
(X_1) LOS 1-4	-60.5 (29.4)	-3.62 (1.30)
(X_2) LOS 5-8	-16.1 (28.9)	3.58 (1.28)
(X_3) LOS 9+	-18.6 (54.6)	-1.13 (2.42)
(P) Aircraft	-634.7 (513.9)	-77.04 (22.79)
$(X_1X_2)^{1/2}$	28.3 (51.4)	-5.81 (2.28)
$(X_1X_3)^{1/2}$	-11.2 (52.9)	-.25 (2.35)
$(X_2X_3)^{1/2}$	48.0 (53.9)	-3.49 (2.39)
$(X_1P)^{1/2}$	391.1 (215.7)	33.22 (9.57)
$(X_2P)^{1/2}$	-150.6 (151.8)	16.00 (6.73)
$(X_3P)^{1/2}$	98.1 (285.3)	12.30 (12.65)

TABLE A-6

COEFFICIENT ESTIMATES: PERFORMANCE ON EXPERIENCE RATING BY GROUP

	Rating Group 1		Rating Group 2		Rating Group 3	
Variable	Flights	MCR	Flights	MCR	Flights	MCR
(X_1) LOS 1-4	-3.4	-3.45	-7.5	.05	-45.6	-3.58
	(113.6)	(5.21)	(73.4)	(3.37)	(34.0)	(1.52)
(X_2) LOS 5-8	22.7	3.34	65.0	8.40	-13.1	3.71
	(29.3)	(1.34)	(52.7)	(2.42)	(49.4)	(2.70)
(X_3) LOS 9+	-102.3	-3.12	-25.9	.94	-131.9	2.01
	(104.3)	(4.78)	(97.8)	(4.49)	(134.2)	(5.98)
(P) Aircraft	-288.0	-24.01	-107.1	-6.45	-581.4	-32.53
	(320.6)	(14.7)	(352.6)	(16.2)	(390.4)	(17.4)
$(X_1X_2)^{1/2}$	-71.5	-4.09	110.8	-8.64	60.4	-4.16
	(129.6)	(5.94)	(95.3)	(4.37)	(51.1)	(2.28)
$(X_1X_3)^{1/2}$	-78.3	-3.19	-168.0	2.26	-70.8	-2.75
	(166.9)	(7.66)	(106.8)	(4.90)	(92.1)	(4.11)
$(X_2X_3)^{1/2}$	67.4	-7.39	204.7	-2.29	-75.7	-6.10
	(97.5)	(4.47)	(103.4)	(4.75)	(96.2)	(4.29)
$(X_1P)^{1/2}$	208.1	18.06	160.9	5.85	230.7	22.28
	(338.5)	(15.52)	(296.6)	(13.61)	(192.2)	(8.57)
$(X_2P)^{1/2}$	-7.4	8.58	-569.2	6.06	-18.4	10.83
	(171.4)	(7.86)	(230.3)	(10.57)	(179.3)	(7.99)
$(X_3P)^{1/2}$	287.4	18.66	296.1	-1.93	610.2	9.94
	(262.2)	(12.02)	(273.0)	(12.53)	(440.5)	(19.64)

TABLE A-7

COEFFICIENT ESTIMATES: PERFORMANCE ON EDUCATION

	Flights	MCR
(X_1) NHS/GED	40.9 (74.7)	4.07 (3.34)
(X_2) HSG	7.4 (29.5)	2.19 (1.32)
(X_3) HS+	16.9 (61.5)	-1.99 (2.75)
(P) Aircraft	-460.5 (427.9)	-49.97 (19.12)
$(X_1X_2)^{1/2}$	-161.6 (76.2)	-11.16 (3.40)
$(X_1X_3)^{1/2}$	132.1 (77.0)	2.40 (3.44)
$(X_2X_3)^{1/2}$	21.4 (65.4)	-4.59 (2.92)
$(X_1P)^{1/2}$	241.0 (285.4)	20.85 (12.75)
$(X_2P)^{1/2}$	260.2 (158.4)	12.97 (7.08)
$(X_3P)^{1/2}$	-352.1 (237.7)	15.59 (10.62)

TABLE A-8

COEFFICIENT ESTIMATES: PERFORMANCE ON EDUCATION BY RATING GROUP

Variable	Rating Group 1 Flights	Rating Group 1 MCR	Rating Group 2 Flights	Rating Group 2 MCR	Rating Group 3 Flights	Rating Group 3 MCR
(X_1) NHS/GED	103.5	6.61	44.0	-.66	10.2	1.36
	(68.6)	(3.05)	(64.9)	(3.00)	(70.4)	(3.15)
(X_2) HSG	-10.4	1.80	38.1	.94	-70.2	2.22
	(47.8)	(2.12)	(59.5)	(2.76)	(68.3)	(3.05)
(X_3) HS+	22.3	1.35	-8.7	1.96	56.2	.76
	(72.9)	(3.25)	(55.3)	(2.56)	(71.6)	(3.20)
(P) Aircraft	-5.6	-10.65	116.2	-10.68	-310.8	-49.19
	(183.8)	(8.18)	(373.7)	(17.30)	(288.0)	(12.87)
$(X_1X_2)^{1/2}$	-146.3	-9.61	-56.1	-2.25	-104.5	-16.62
	(103.2)	(4.61)	(105.8)	(4.90)	(100.0)	(4.47)
$(X_1X_3)^{1/2}$	85.0	2.42	94.3	-1.17	-52.6	-1.42
	(111.5)	(4.96)	(84.1)	(3.89)	(83.0)	(3.71)
$(X_2X_3)^{1/2}$	89.7	-8.44	59.8	-6.03	173.9	-11.77
	(107.9)	(4.80)	(88.2)	(4.08)	(99.2)	(4.43)
$(X_1P)^{1/2}$	51.8	5.90	5.3	8.69	189.4	32.17
	(215.7)	(9.60)	(277.5)	(12.84)	(213.5)	(9.54)
$(X_2P)^{1/2}$	109.5	8.56	-76.7	3.41	345.9	21.44
	(138.1)	(6.15)	(255.9)	(11.84)	(232.8)	(10.41)
$(X_3P)^{1/2}$	236.5	10.28	-217.4	12.83	-361.1	26.09
	(237.3)	(10.56)	(200.7)	(9.29)	(221.1)	(9.88)

TABLE A-9

COEFFICIENT ESTIMATES: PERFORMANCE ON MENTAL GROUP

	Flights	MCR
(X_1) MG 1-2	-37.6 (31.5)	-2.53 (1.43)
(X_2) MG 3	-34.7 (45.1)	-3.84 (2.05)
(X_3) MG 4-5	4.9 (52.2)	3.30 (2.37)
(P) Aircraft	-339.7 (375.9)	-28.93 (17.09)
$(X_1X_2)^{1/2}$	-28.5 (61.0)	.30 (2.78)
$(X_1X_3)^{1/2}$	174.2 (61.3)	4.71 (2.79)
$(X_2X_3)^{1/2}$	-85.9 (76.3)	-3.69 (3.47)
$(X_1P)^{1/2}$	-40.4 (131.7)	3.28 (5.99)
$(X_2P)^{1/2}$	429.7 (238.5)	28.0 (10.84)
$(X_3P)^{1/2}$	-195.8 (224.4)	-12.51 (10.20)

TABLE A-10

COEFFICIENT ESTIMATES: PERFORMANCE ON MENTAL GROUPS BY RATING GROUP

Variable	Rating Group 1 Flights	Rating Group 1 MCR	Rating Group 2 Flights	Rating Group 2 MCR	Rating Group 3 Flights	Rating Group 3 MCR
(X_1) MG 1-2	-35.4	-1.32	-5.2	.06	-25.8	.82
	(39.4)	(1.77)	(44.8)	(2.08)	(63.1)	(2.81)
(X_2) MG 3	51.6	.74	-19.9	.59	-125.0	-6.25
	(107.6)	(4.84)	(57.1)	(2.64)	(63.7)	(2.83)
(X_3) MG 4-5	59.8	2.89	32.3	2.65	-139.9	-.62
	(47.9)	(2.16)	(44.6)	(2.07)	(72.7)	(3.23)
(P) Aircraft	11.4	-4.19	184.9	-5.80	-509.4	-46.18
	(201.7)	(9.08)	(328.6)	(15.23)	(288.1)	(12.80)
$(X_1X_2)^{1/2}$	70.3	.26	55.7	-3.59	-1.2	-4.60
	(69.3)	(3.12)	(62.4)	(2.89)	(97.0)	(4.31)
$(X_1X_3)^{1/2}$	-37.7	-8.09	95.0	3.12	33.6	-.47
	(84.3)	(3.80)	(67.6)	(3.13)	(96.9)	(4.30)
$(X_2X_3)^{1/2}$	-120.4	3.70	2.5	-3.13	36.5	-7.16
	(107.9)	(4.86)	(67.2)	(3.11)	(109.7)	(4.87)
$(X_1P)^{1/2}$	79.3	8.25	-157.7	3.32	33.6	7.43
	(144.0)	(6.48)	(181.3)	(8.40)	(185.1)	(8.23)
$(X_2P)^{1/2}$	-157.7	-2.70	31.5	7.60	393.0	38.70
	(283.3)	(12.71)	(245.4)	(11.4)	(214.7)	(9.54)
$(X_3P)^{1/2}$	164.2	8.08	-187.1	-2.80	287.1	15.18
	(213.1)	(9.59)	(191.7)	(8.88)	(223.9)	(9.95)

CNA PROFESSIONAL PAPERS - 1978 TO PRESENT*

PP 211
Mizrahi, Maurice M., "On Approximating the Circular Coverage Function," 14 pp., Feb 1978, AD A054 429

PP 212
Mangel, Marc, "On Singular Characteristic Initial Value Problems with Unique Solution," 20 pp., Jun 1978, AD A058 535

PP 213
Mangel, Marc, "Fluctuations in Systems with Multiple Steady States. Application to Lanchester Equations," 12 pp., Feb 78 (Presented at the First Annual Workshop on the Information Linkage Between Applied Mathematics and Industry, Naval PG School, Feb 23-25, 1978), AD A071 47[illegible]

PP 214
Weinland, Robert G., "A Somewhat Different View of The Optimal Naval Posture," 37 pp., Jun 1978 (Presented at the 1976 Convention of the American Political Science Association (APSA/IUS Panel on "Changing Strategic Requirements and Military Posture"), Chicago, Ill., September 2, 1976), AD A056 228

PP 215
Colle, Russell C., "Comments on: Principles of Information Retrieval by Manfred Kochen," 10 pp., Mar 78 (Published as a Letter to the Editor, *Journal of Documentation*, Vol. 31, No. 4, pages 298-301), December 1975), AD A054 426

PP 216
Colle, Russell C., "Lotka's Frequency Distribution of Scientific Productivity," 18 pp., Feb 1978 (Published in the Journal of the American Society for Information Science, Vol. 28, No. 6, pp. 366-370, November 1977), AD A054 425

PP 217
Colle, Russell C., "Bibliometric Studies of Scientific Productivity," 17 pp., Mar 78 (Presented at the Annual meeting of the American Society for Information Science held in San Francisco, California, October 1976), AD A054 442

PP 218 - Classified

PP 219
Huntzinger, R. LaVar, "Market Analysis with Rational Expectations: Theory and Estimation," 60 pp., Apr 78, AD A054 422

PP 220
Maurer, Donald E., "Diagonalization by Group Matrices," 26 pp., Apr 78, AD A054 443

PP 221
Weinland, Robert G., "Superpower Naval Diplomacy in the October 1973 Arab-Israeli War," 76 pp., Jun 1978 (Published in *Seapower in the Mediterranean: Political Utility and Military Constraints*, The Washington Papers No. 61, Beverly Hills and London: Sage Publications, 1979) AD A055 564

PP 222
Mizrahi, Maurice M., "[illegible] Rules and Path Integrals," 3[illegible] pp., Jun 1978 (Invited paper presented at the CNRS meeting on "Mathematical Problems in Feynman's Path Integrals," Marseille, France, May 22-26, 1978) (Published in Springer Verlag Lecture Notes in Physics, [illegible]) AD A056 [illegible]

PP 223
Mangel, Marc, "Stochastic Mechanics of Molecule-Molecule Reactions," [illegible] pp., Jun 1978, AD A[illegible]

PP 224
Mangel, Marc, "Aggregation, Bifurcation, and Extinction in Exploited Animal Populations*," 48 pp., Mar 1978, AD A058 536
*Portions of this work were started at the Institute of Applied Mathematics and Statistics, University of British Columbia, Vancouver, B.C., Canada

PP 225
Mangel, Marc, "Oscillations, Fluctuations, and the Hopf Bifurcation*," 43 pp., Jun 1978, AD A058 537
*Portions of this work were completed at the Institute of Applied Mathematics and Statistics, University of British Columbia, Vancouver, Canada.

PP 226
Ralston, J. M. and J. W. Mann,* "Temperature and Current Dependence of Degradation in Red-Emitting GaP LEDs," 34 pp., Jun 1978 (Published in Journal of Applied Physics, 50, 3630, May 1979) AD A058 538
*Bell Telephone Laboratories, Inc.

PP 227
Mangel, Marc, "Uniform Treatment of Fluctuations at Critical Points," 50 pp., May 1978, AD A058 539

PP 228
Mangel, Marc, "Relaxation at Critical Points: Deterministic and Stochastic Theory," 54 pp., Jun 1978, AD A058 540

PP 229
Mangel, Marc, "Diffusion Theory of Reaction Rates, I: Formulation and Einstein-Smoluchowski Approximation," 50 pp., Jan 1978, AD A058 541

PP 230
Mangel, Marc, "Diffusion Theory of Reaction Rates, II Ornstein-Uhlenbeck Approximation," 34 pp., Feb 1978, AD A058 542

PP 231
Wilson, Desmond P., Jr., "Naval Projection Forces: The Case for a Responsive MAF," Aug 1978, AD A054 543

PP 232
Jacobson, Louis, "Can Policy Changes Be Made Acceptable to Labor?" Aug 1978 (Submitted for publication in Industrial and Labor Relations Review), AD A061 528

*CNA Professional Papers with an AD number may be obtained from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151. Other papers are available from the Management Information Office, Center for Naval Analyses, 2000 North Beauregard Street, Alexandria, Virginia 22311. An Index of Selected Publications is also available on request. *The Index includes a Listing of Professional Papers; with abstracts; issued from 1969 to June 1981.*

PP 233
Jacobson, Louis, "An Alternative Explanation of the Cyclical *Pattern of Quits*," 23 pp., Sep 1978

PP 234 - *Revised*
Jondrow, James and Levy, Robert A., "Does Federal Expenditure Displace State and Local Expenditure: The Case of Construction Grants," 25 pp., Oct 1979, AD A061 529

PP 235
Mizrani, Maurice M., "The Semiclassical Expansion of the Anharmonic-Oscillator Propagator," 41 pp., Oct 1978 (Published in Journal of Mathematical Physics 20 (1979) pp. 844-855), AD A061 538

PP 237
Maurer, Donald, "A Matrix Criterion for Normal Integral Bases," 10 pp., Jan 1979 (Published in the Illinois Journal of Mathematics, Vol. 22 (1978), pp. 672-681

PP 238
Utgoff, Kathleen Classen, "Unemployment Insurance and The Employment Rate," 20 pp., Oct 1978 (Presented at the Conference on Economic Indicators and Performance: The Current Dilemma Facing Government and Business Leaders, presented by Indiana University Graduate School of Business). AD A061 527

PP 239
Trost, R. P. and Warner, J. T., "The Effects of Military Occupational Training on Civilian Earnings: An Income Selectivity Approach," 38 pp., Nov 1979k, AD A077 831

PP 240
Powers, Bruce, "Goals of the Center for Naval Analyses," 13 pp., Dec 1978, AD A063 759

PP 241
Mangel, Marc, "Fluctuations at Chemical Instabilities," 24 pp., Dec 1978 (Published in Journal of Chemical Physics, Vol. 69, No. 8, Oct 15, 1978). AD A063 787

PP 242
Simpson, William R., "The Analysis of Dynamically Interactive Systems (Air Combat by the Numbers)," 160 pp., Dec 1978, AD A063 760

PP 243
Simpson, William R., "A Probabilistic Formulation of Murphy Dynamics as Applied to the Analysis of Operational Research Problems," 18 pp., Dec 1978, AD A063 761

PP 244
Sherman, Allen and Horowitz, Stanley A., "Maintenance Costs *of Complex Equipment*," 20 pp., Dec 1978 (*Published By The* American Society of Naval Engineers, Naval Engineers Journal, Vol. 91, No. 6, Dec 1979) AD A071 473

PP 245
Simpson, William R., "*The Accelerometer Methods of Obtaining* Aircraft Performance from Flight Test Data (Dynamic Performance Testing)," 403 pp., Jun 1979, AD A075 226

PP 246
Brechling, Frank, "*Layoffs and Unemployment Insurance*," 35 pp., Feb 1979 (Presented at the Nber Conference on "Low Income Labor Markets," Chicago, Jun 1978), AD A096 629

PP 248
Thomas, James A., Jr., "The Transport Properties of Dilute Gases in Applied Fields," 183 pp., Mar 1979, AD A096 464

PP 249
Glasser, Kenneth S., "A Secretary Problem with a Random Number of Choices," 23 pp., Mar 1979

PP 250
Mangel, Marc, "Modeling Fluctuations in Macroscopic Systems," 26 pp., Jun 1979

PP 251
Trost, Robert P., "*The Estimation and Interpretation of* Several Selectivity Models," 37 pp., Jun 1979, AD A075 941

PP 252
Nunn, Walter R., "Position Finding with Prior Knowledge of Covariance Parameters," 5 pp., Jun 1979 (*Published in IEEE* Transactions on Aerospace & Electronic Systems, Vol. AES-15, No. 3, Mar 1979

PP 253
Glasser, *Kenneth S.*, "*The d-Choice Secretary Problem*," 32 pp., Jun 1979, AD A075 225

PP 254
Mangel, Marc and Quanbeck, David B., "Integration of a Bivariate Normal Over an Offset Circle," 14 pp., Jun 1979, AD A096 471

PP 255 - Classified, AD B051 441L

PP 256
Maurer, Donald E., "Using Personnel Distribution Models," 27 pp., Feb 1980, AD A082 218

PP 257
Thaler, R., "Discounting and Fiscal Constraints: Why Discounting Is Always Right," 10 pp., Aug 1979, AD A075 224

PP 258
Mangel, Marc S. and Thomas, James A., Jr., "Analytical Methods in Search Theory," 86 pp., Nov 1979, AD A077 832

PP 259
Glass, David V.; Hsu, Ih-Ching; Nunn, Walter R., and Perin, David A., "A Class of Commutative Markov Matrices," 17 pp., Nov 1979, AD A077 833

PP 260
Mangel, Marc S. and Cope, Davis K., "Detection Rate and Sweep Width in Visual Search," 14 pp., Nov 1979, AD A077 834

PP 261
Vila, Carlos L.; Zvijac, David J. and Ross, John, "Franck-Condon Theory of Chemical Dynamics. VI. Angular Distributions of Reaction Products," 14 pp., Nov 1979 (Reprinted from Journal Chemical Phys. 70(12), 15 Jun 1979), AD A076 287

PP 262
Petersen, Charles C., "*Third World Military Elites in Soviet Perspective*," 50 pp., Nov 1979, AD A077 835

PP 263
Robinson, Kathy I., "Using Commercial Tankers and Containerships for Navy Underway Replenishment," 25 pp., Nov 1979, AD A077 836

PP 264
Weinland, Robert G., "The U.S. Navy in the Pacific: Past, Present, and Glimpses of the Future," 31 pp., Nov 1979 (Delivered at the International Symposium on the Sea, sponsored by the International Institute for Strategic Studies, The Brookings Institution and the Yomiuri Shimbun, Tokyo, 16-20 Oct 1978) AD A066 837

PP 265
Weinland, Robert G., "War and Peace in the North: Some Political Implications of the Changing Military Situation in Northern Europe," 18 pp., Nov 1979 (Prepared for presentation to the Conference of the Nordic Balance in Perspective: The Changing Military and Political Situation," Center for Strategic and International Studies, Georgetown University, Jun 15-16, 1978) AD A077 838

PP 266
Utgoff, Kathy Classen, and Brechling, Frank, "Taxes and Inflation," 25 pp., Nov 1979, AD A081 194

PP 267
Trost, Robert P., and Vogel, Robert C., "The Response of State Government Receipts to Economic Fluctuations and the Allocation of Counter-Cyclical Revenue Sharing Grants," 12 pp., Dec 1979 (Reprinted from the Review of Economics and Statistics, Vol. LXI, No. 3, August 1979)

PP 268
Thomason, James S., "Seaport Dependence and Inter-State Cooperation: The Case of Sub-Saharan Africa," 141 pp., Jan 1980, AD A081 193

PP 269
Weiss, Kenneth G., "The Soviet Involvement in the Ogaden War," 42 pp., Jan 1980 (Presented at the Southern Conference on Slavic Studies in October, 1979), AD A082 219

PP 270
Remnek, Richard, "Soviet Policy in the Horn of Africa: The Decision to Intervene," 52 pp., Jan 1980 (To be published in "The Soviet Union in the Third World: Success or Failure," ed. by Robert H. Donaldson, Westview Press, Boulder, Co., Summer 1980), AD A081 195

PP 271
McConnell, James, "Soviet and American Strategic Doctrines: One More Time," 43 pp., Jan 1980, AD A081 192

PP 272
Weiss, Kenneth G., "The Azores in Diplomacy and Strategy, 1940-1945, 46 pp., Mar 1980, AD A085 094

PP 273
Nakada, Michael K., "Labor Supply of Wives with Husbands Employed Either Full Time or Part Time," 39 pp., Mar 1980, AD A082 220

PP 274
Nunn, Walter R., "A Result in the Theory of Spiral Search," 9 pp., Mar 1980

PP 275
Goldberg, Lawrence, "Recruiters Advertising and Navy Enlistments," 34 pp., Mar 1980, AD A082 221

PP 276
Goldberg, Lawrence, "Delaying an Overhaul and Ship's Equipment," 40 pp., May 1980, AD A085 095

PP 277
Mangel, Marc, "Small Fluctuations in Systems with Multiple Limit Cycles," 19 pp., Mar 1980 (Published in SIAM J. Appl. Math., Vol. 38, No. 1, Feb 1980) AD A086 229

PP 278
Mizrahi, Maurice, "A Targeting Problem: Exact vs. Expected-Value Approaches," 23 pp., Apr 1980, AD A085 096

PP 279
Walt, Stephen M., "Causal Inferences and the Use of Force: A Critique of Force Without War," 50 pp., May 1980, AD A085 097

PP 280
Goldberg, Lawrence, "Estimation of the Effects of A Ship's Steaming on the Failure Rate of Its Equipment: An Application of Econometric Analysis," 25 pp., Apr 1980, AD A085 098

PP 281
Mizrahi, Maurice M., "Comment on 'Discretization Problems of Functional Integrals in Phase Space'," 2 pp., May 1980, published in "Physical Review D", Vol. 22 (1980), AD A094 994

PP 283
Dismukes, Bradford, "Expected Demand for the U.S. Navy to Serve as An Instrument of U.S. Foreign Policy: Thinking About Political and Military Environmental Factors," 30 pp., Apr 1980, AD A085 099

PP 284
J. Kellson,* W. Nunn, and U. Sumita,** "The Laguerre Transform," 119 pp., May 1980, AD A085 100
*The Graduate School of Management, University of Rochester and the Center for Naval Analyses
**The Graduate School of Management, University of Rochester

PP 285
Remnek, Richard B., "Superpower Security Interests in the Indian Ocean Area," 26 pp., Jun 1980, AD A087 113

PP 286
Mizrahi, Maurice M., "On the WKB Approximation to the Propagator for Arbitrary Hamiltonians," 25 pp., Aug 1980 (Published in Journal of Math. Phys., 22(1) Jan 1981), AD A091 307

PP 287
Cope, Davis, "Limit Cycle Solutions of Reaction-Diffusion Equations," 35 pp., Jun 1980, AD A087 114

PP 288
Golman, Walter, "Don't Let Your Slides Flip You: A Painless Guide to Visuals That Really Aid," 28 pp., (revised Aug 1982), AD A092 732

PP 289
Robinson, Jack, "Adequate Classification Guidance - A Solution and a Problem," 7 pp., Aug 1980, AD A091 212

PP 290
Watson, Gregory H., "Evaluation of Computer Software in an Operational Environment," 17 pp., Aug 1980, AD A091 213

PP 291
Maddala, G. S.* and Trost, R. P., "Some Extensions of the Nerlove Press Model," 17 pp., Oct 1980, AD A091 946
*University of Florida

PP 292
Thomas, James A., Jr., "The Transport Properties of Binary Gas Mixtures in Applied Magnetic Fields," 10 pp., Sept 1980 (Published in Journal of Chemical Physics 72(10), 15 May 1980

PP 293
Thomas, James A., Jr., "Evaluation of Kinetic Theory Collision Integrals Using the Generalized Phase Shift Approach," 12 pp., Sept 1980 (Printed in Journal of Chemical Physics 72(10), 15 May 1980

PP 294
Roberts, Stephen S., "French Naval Policy Outside of Europe," 30 pp., Sept 1980 (Presented at the Conference of the Section on Military Studies, International Studies Association Kiawah Island, S.C.), AD A091 306

PP 295
Roberts, Stephen S., "An Indicator of Informal Empire: Patterns of U.S. Navy Cruising on Overseas Stations, 1869-1897," 40 pp., Sept 1980 (Presented at Fourth Naval History Symposium, US Naval Academy, 26 October 1979, AD A091 316

PP 296
Dismukes, Bradford and Petersen, Charles C., "Maritime Factors Affecting Iberian Security," (Factores Maritimos Que Afectan La Securidad Ibelca) 14 pp., Oct 1980, AD A092 733

PP 297 - Classified

PP 298
Mizrahi, Maurice M., "A Markov Approach to Large Missile Attacks," 31 pp., Jan 1981, AD A096,159

PP 299
Jondrow, James M. and Levy, Robert A., "Wage Leadership in Construction, 19 pp., Jan 1981, AD A094 797

PP 300
Jondrow, James and Schmidt, Peter,* "On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model," 11 pp., Jan 1981, AD A096 160
*Michigan State University

PP 301
Jondrow, James M., Levy, Robert A. and Hughes, Claire, "Technical Change and Employment in Steel, Autos, Aluminum, and Iron Ore, 17 pp., Mar 1981, AD A099 394

PP 302
Jondrow, James M. and Levy, Robert A., "The Effect of Imports on Employment Under Rational Expectations," 19 pp., Apr 1981, AD A099 392

PP 303
Thomason, James, "The Rarest Commodity in the Coming Resource Wars," 3 pp., Aug 1981 (Published in the Washington Star, April 13, 1981)

PP 304
Duffy, Michael K.; Greenwood, Michael J.* and McDowell, John M.,** "A Cross-Sectional Model of Annual Interregional Migration and Employment Growth: Intertemporal Evidence of Structural Change, 1958-1975," 31 pp., Apr 1981, AD A099 393
*University of Colorado
**Arizona State University

PP 305
Nunn, Laura H., "An Introduction to the Literature of Search Theory," 32 pp., Jun 1981

PP 306
Anger, Thomas E., "What Good Are Warfare Models?" 7 pp., May 1981

PP 307
Thomason, James, "Dependence, Risk, and Vulnerability," 43 pp., Jun 1981

PP 308
Mizrahi, M.M., "Correspondence Rules and Path Integrals," Jul 1981. Published in "Nuovo Cimento B", Vol. 61 (1981)

PP 309
Weinland, Robert G., "An (The?) Explanation of the Soviet Invasion of Afghanistan," 44 pp., May 1981

PP 310
Stanford, Janette M. and Tai Te Wu,* "A Predictive Method for Determining Possible Three-dimensional Foldings of Immunoglobulin Backbones Around Antibody Combining Sites," 19 pp., Jun 1981 (Published in J. theor. Biol. (1981) 88, 421-439
*Northwestern University, Evanston, IL

PP 311
Bowes, Marianne, Brechling, Frank P. R., and Utgoff, Kathleen P. Classen, "An Evaluation of UI Funds," 13 pp., May 1981 (Published in National Commission on Unemployment Compensation's Unemployment Compensation: Studies and Research, Volume 2, July 1980)

PP 312
Jondrow, James; Bowes, Marianne and Levy, Robert, "The Optimum Speed Limit," 23 pp., May 1981

PP 313
Roberts, Stephen S., "The U.S. Navy in the 1980s," 36 pp., Jul 1981

PP 314
Jehn, Christopher; Horowitz, Stanley A. and Lockman, Robert F., "Examining the Draft Debate," 20 pp., Jul 1981

PP 315
Buck, Ralph V., Capt., "Le Catastrophe by any other name...," 4 pp., Jul 1981

PP 316
Roberts, Stephen S., "Western European and NATO Navies, 1980," 20 pp., Aug 1981

PP 317
Roberts, Stephen S., "Superpower Naval Crisis Management in the Mediterranean," 35 pp., Aug 1981

PP 318
Vego, Milan N., "Yugoslavia and the Soviet Policy of Force in the Mediterranean Since 1961," 187 pp., Aug 1981

PP 319
Smith, Michael W., "Antiair Warfare Defense of Ships at Sea," 46 pp., Sep 1981 (This talk was delivered at the Naval Warfare System and Technology Conference of the American Institute of Aeronautics and Astronautics in Washington on December 12, 1980; in Boston on January 20, 1981; and in Los Angeles on June 12, 1981.)

PP 320
Trost, R. P.; Lurie, Philip and Berger, Edward, "A Note on Estimating Continuous Time Decision Models," 15 pp., Sep 1981

PP 321
Duffy, Michael K. and Ladman, Jerry R.,* "The Simultaneous Determination of Income and Employment in United States--Mexico Border Region Economies," 34 pp., Sep 1981
*Associate Professor of Economics, Arizona State University, Tempe, AZ.

PP 322
Warner, John T., "Issues in Navy Manpower Research and Policy: An Economist's Perspective," 66 pp., Dec 1981

PP 323
Bomse, Frederick M., "Generation of Correlated Log-Normal Sequences for the Simulation of Clutter Echoes," 33 pp., Dec 1981

PP 324
Horowitz, Stanley A., "Quantifying Seapower Readiness," 6 pp., Dec 1981 (Published in Defense Management Journal, Vol. 18, No. 2)

PP 326
Roberts, Stephen S., "Western European and NATO Navies, 1981," 27 pp., Jul 1982

PP 327
Hammon, Colin, Capt., USN and Graham, David R., Dr., "Estimation and Analysis of Navy Shipbuilding Program Disruption Costs," 12 pp., Mar 1980

PP 328
Weinland, Robert G., "Northern Waters: Their Strategic Significance," 27 pp., Dec 1980

PP 329
Mangel, Marc, "Applied Mathematicians And Naval Operators," 40 pp., Mar 1982 (Revised)

PP 330
Lockman, Robert F., "Alternative Approaches to Attrition Management," 30 pp., Jan 1982

PP 331
Roberts, Stephen S., "The Turkish Straits and the Soviet Navy in the Mediterranean," 15 pp., Mar 1982 (Published in Navy International)

PP 332
Jehn, Christopher, "The RDF and Amphibious Warfare," 36 pp., Mar 1982

PP 333
Lee, Lung-Fei and Trost, Robert P., "Estimation of Some Limited Dependent Variable Models with Application to Housing Demand," 26 pp., Jan 1982. (Published in Journal of Econometrics 8 (1978) 357-382)

PP 334
Kenny, Lawrence W., Lee, Lung-Fei, Maddala, G. S., and Trost R. P., "Returns to College Education: An Investigation of Self-Selection Bias Based on the Project Talent Data," 15 pp., Jan 1982. (Published in International Economic Review, Vol. 20, No. 3, October 1979)

PP 335
Lee, Lung-Fei, G.S. Maddala, and R. P. Trost, "Asymptotic Covariance Matrices of Two-Stage Probit and Two-Stage Tobit Methods for Simultaneous Equations Models with Selectivity," 13 pp., Jan 1982. (Published in Econometrica, Vol. 48, No. 2 (March, 1980))

PP 336
O'Neill, Thomas, "Mobility Fuels for the Navy," 13 pp., Jan 1982. (Accepted for publication in Naval Institute Proceedings)

PP 337
Warner, John T. and Goldberg, Matthew S., "The Influence of Non-Pecuniary Factors on Labor Supply," 23 pp., Dec 1981

PP 339
Wilson, Desmond P., "The Persian Gulf and the National Interest," 11 pp., Feb 1982

PP 340
Lurie, Philip, Trost, R. P., and Berger, Edward, "A Method for Analyzing Multiple Spell Duration Data," 34 pp., Feb 1982

PP 341
Trost, Robert P. and Vogel, Robert C., "Prediction with Pooled Cross-Section and Time-Series Data: Two Case Studies," 6 pp., Feb 1982

PP 342
Lee, Lung-Fei, Maddala, G. S., and Trost, R. P., "Testing for Structural Change by D-Methods in Switching Simultaneous Equations Models," 5 pp., Feb 1982

PP 343
Goldberg, Matthew S., "Projecting the Navy Enlisted Force Level," 9 pp., Feb 1982

PP 344
Fletcher, Jean, W., "Navy Quality of Life and Reenlistment," 13 pp., Nov 1981

PP 345
Utgoff, Kathy and Thaler, Dick, "The Economics of Multi Year Contracting," 47 pp., Mar 1982. (Presented at the 1982 Annual Meeting of the Public Choice Society, San Antonio, Texas, March 5-7, 1982)

PP 346
Rostker, Bernard, "Selective Service and the All-Volunteer Force," 23 pp., Mar 1982

PP 347
McConnell, James, M., "A Possible Counterforce Role for the Typhoon," 24 pp., Mar 1982

PP 348
Jondrow, James, Trost, Robert, "An Empirical Study of Production Inefficiency in the Presence of Errors-in-The-Variables," 14 pp., Feb 1982

PP 349
W. H. Breckenridge, O. Kim Malmin, "Collisional Intra-multiplet Relaxation of Cd($5s5p^3P_{0,1,2}$) by Alkane Hydrocarbons," 7 pp., Jul 1981. (Published in Journal of Chemical Physics, 76(4), 15 Feb 1982)

PP 350
Levin, Marc, "A Method for Increasing the Firepower of Virginia Class Cruisers," 10 pp., Apr 1982. (To be published in U.S. Naval Institute Proceedings)

PP 351
Coutre, S. E.; Stanford, J. M.; Hovis, J. G.; Stevens, P. W.; Wu, T. T., "Possible Three-Dimensional Backbone Folding Around Antibody Combining Site of Immunoglobulin MOPC 167," 18 pp., Apr 1982. (Published in Journal of Theoretical Biology)

PP 352
Barfoot, C. Bernard, "Aggregation of Conditional Absorbing Markov Chains," 7 pp., June 1982 (Presented to the Sixth European Meeting on Cybernetics and Systems Research, held at the University of Vienna, Apr 1982.)

PP 353
Barfoot, C. Bernard, "Some Mathematical Methods for Modeling the Performance of a Distributed Data Base System," 18 pp/. June 1982. (Presented to the International Working Conference on Model Realism, held at Bad Honnek, West Germany, Apr 1982.)

PP 354
Hall, John V., "Why the Short-War Scenario is Wrong for Naval Planning," 6 pp., Jun 1982.

PP 356
Goldberg, Matthew S., "Estimation of the Personal Discount Rate: Evidence from Military Reenlistment Decisions," 19 pp., Apr 1982.

PP 357
Goldberg, Matthew S., "Discrimination, Nepotism, and Long-Run Wage Differentials," 13 pp., Sep 1982. (Published in Quarterly Journal of Economics, May 1982)

PP 358
Akst, George, "Evaluating Tactical Command And Control Systems—A Three-Tiered Approach," 12 pp., Sep 1982.

PP 361
Quanbeck, David B., "Methods for Generating Aircraft Trajectories," 51 pp., Sep 1982.

PP 362
Horowitz, Stanley A., "Is the Military Budget Out of Balance?," 10 pp., Sep 1982.

PP 363
Marcus, A. J., "Personnel Substitution and Navy Aviation Readiness," 35 pp., Oct 1982.

DATE
FILMED

1-83

DTIC